

Claims 1 through 4 and 6 were rejected under Section 102(b) as anticipated by the Nozaki et al. reference. Claims 5, 7, 9, 10, and 11 were rejected under Section 103 as unpatentable over the Nozaki et al. reference in view of the Tseng reference; on the basis that the Tseng reference supplies teachings relative to the use of a silicon nitride capacitor dielectric, for which disclosure was lacking in the Nozaki et al. reference. Claims 8 and 13 were rejected under Section 103 as unpatentable over the Nozaki et al. reference in view of the Taft reference, on the basis that the Taft reference teaches the use of a silicon nitride dielectric over a silicon substrate and under a gate structure, for which the Nozaki et al. reference lacked disclosure. Claim 12 was rejected under Section 103 as unpatentable over the Nozaki et al. reference in view of the Tseng reference and further in view of the Iyer reference; the Tseng reference was asserted as teaching an oxynitride capacitor dielectric, while the Iyer reference was asserted as teaching the reaction of nitrogen and oxygen gases in a plasma discharge.

Claim 1 is amended above to overcome the rejection, and for clarity. Amended claim 1 now recites the step of providing a gas comprising a mixture of nitrogen and oxygen to a silicon-containing structure; the method further requires elevating the temperature of the structure and striking a plasma above the structure, to cause thermal nitridation and oxidation of a portion of the silicon-containing structure. Because the specification clearly supports the use of both nitrogen and oxygen in the gas,<sup>1</sup> Applicant respectfully submits that no new matter is presented by this amendment.

Claims 4 and 5 are amended for consistency with the amendment to claim 1. Claim 6 is cancelled.

The method of amended claim 1 provides important advantages over conventional techniques. As described in the specification, conventional techniques involve silicon nitride films that are of relatively poor quality unless a silicon dioxide layer is also formed.<sup>2</sup> Known techniques for forming silicon nitride films that overcome this limitation involve significant

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<sup>1</sup> See, e.g., specification of S.N. 09/085,298, at page 7, lines 10 and 11; page 7, line 28, through page 8, line 3; page 10, lines 4 through 6.

<sup>2</sup> Specification, *supra*, page 2, lines 1 through 12.

expense, contamination of the resulting structure, or trapped charge effects.<sup>3</sup> In contrast, the method of amended claim 1 provides high-quality films, suitable for use in high performance integrated circuits such as DRAMs, logic devices, and the like.<sup>4</sup>

Applicant respectfully submits that amended claim 1 and its dependent claims are patentably distinct over the prior art of record. Applicant respectfully submits that the Nozaki et al. reference fails to disclose the use of a gas comprising both nitrogen and oxygen in the formation of a dielectric. Rather, the reference teaches only the use of nitrogen sources in its gas,<sup>5</sup> to avoid oxygen concentration in the resulting structure.<sup>6</sup> Accordingly, Applicant respectfully submits that amended claim 1 and its dependent claims are novel over the Nozaki et al. reference.

Applicant further respectfully submits that there is no suggestion from the prior art to modify the teachings of the Nozaki et al. reference in such a manner as to reach the requirements of amended claim 1. First, Applicant submits that the Nozaki et al. reference itself urges against significant oxygen in its resulting films, to the extent that any oxygen in the resulting film is "adsorbed . . . as foreign matter."<sup>7</sup> As such, regardless of the teachings of the prior art, Applicant respectfully submits that the Nozaki et al. reference would lead one away from incorporating oxygen into its process.

Secondly, Applicant respectfully submits that the secondary references fail to provide suggestion to modify the teachings of the Nozaki et al. reference in such a manner as to reach amended claim 1. The Tseng reference, while disclosing a capacitor dielectric including silicon nitride and silicon dioxide, discloses that these films are formed by way of chemical vapor deposition to form the nitride, followed by oxidation of the nitride.<sup>8</sup> There is no disclosure in the Tseng reference regarding the formation of a dielectric film from a gas comprising a mixture

<sup>3</sup> Specification, *supra*, page 2, line 13 through page 3, line 17.

<sup>4</sup> See specification, *supra*, page 6, line 14, through page 7, line 17.

<sup>5</sup> U.S. Patent No. 4,298,629 to Nozaki et al., at column 3, lines 22 through 29; at column 4, lines 33 through 36.

<sup>6</sup> Nozaki et al., *supra*, at column 3, lines 3 through 6.

<sup>7</sup> Nozaki et al., *supra*, at column 6, lines 20 through 22. See also column 6, lines 51 through 58.

<sup>8</sup> U.S. Patent No. 5,643,819, to Tseng, at column 8, lines 5 through 19.

of nitrogen and oxygen, in combination with elevated temperature and the striking of a plasma.

*filed* The Iyer reference also provides no teachings regarding the formation of a dielectric layer by thermal nitridation and thermal oxidation of a silicon-containing structure; rather, the passivation film disclosed by the Iyer reference is formed by plasma assisted chemical vapor deposition of the silicon oxinitride film (with no reaction therefore occurring at the surface).<sup>9</sup> The Taft et al. reference also provides no teachings in this regard. As such, there is no teaching of the providing, heating, and striking steps of amended claim 1 in any of the secondary references. Accordingly, Applicant respectfully submits that there can be no suggestion from the secondary references to modify the teachings of the Nozaki et al. reference in such a manner as to reach amended claim 1.

Especially considering the benefits provided by the method of amended claim 1, Applicant therefore respectfully submits that amended claim 1 and its dependent claims are patentably distinct over the applied references in this case.

Claim 7 is also amended for clarity and to overcome the rejection. Amended claim 7 now requires the providing of a gas comprising a mixture of nitrogen and oxygen over a bottom structure, heating this structure to a temperature at least 900C, and creating a plasma over the structure to cause its thermal nitridation and thermal oxidation, to form a dielectric over the structure. Claims 11 and 12 are cancelled accordingly. As noted above relative to claim 1, no new matter is provided by this amendment to claim 7. The claimed method provides the important benefits noted above relative to amended claim 1.

Applicant respectfully submits that amended claim 7 and its dependent claims are patentably distinct over the prior art of record in this case. As discussed above relative to amended claim 1, the Nozaki et al. reference discloses the formation of a silicon nitride film, but also teaches that oxygen in the final structure is to be avoided. As such, the Nozaki et al. reference fails to disclose the use of a mixture of nitrogen and oxygen as the reactive gas, and indeed urges against the inclusion of oxygen in its process. The secondary references applied against the claims fail to suggest modifying the Nozaki et al. teachings in such a manner as to

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<sup>9</sup> U.S. Patent No. 5,946,542, to Iyer, at column 4, lines 46 through 61; column 5, lines 17 through 40.

reach amended claim 7, considering that the Tseng reference teaches the formation of its film by deposition of nitride and its subsequent oxidation, and considering that the Iyer reference teaches chemical vapor deposition of its silicon oxinitride. The Taft et al. reference also provides no teachings in this regard. Since none of the secondary references provide any teaching regarding the creating of a plasma over a heated structure to which a gas comprising a mixture of nitrogen and oxygen has been provided, as required by amended claim 7 and its dependent claims, Applicant respectfully submits that these references provide no suggestion to modify the teachings of the Nozaki et al. reference in such a manner as to reach the claim. Considering the advantages provided by the claimed invention, Applicant respectfully submits that amended claim 7 and its dependent claims are patentably distinct over the prior art of record in this case.

Similarly, independent claim 13 is amended to overcome the Section 103 rejection. The method of forming a gate dielectric layer of amended claim 13 now requires the providing of a gas comprised of a mixture of nitrogen and oxygen, heating a substrate to an elevated temperature greater than 900C, and subjecting the substrate to a plasma, where the combination of the gas, temperature, and plasma cause thermal nitridation and oxidation of a portion of the substrate. The claimed method then further requires the forming of a gate electrode over the nitrified and oxidized portion of the substrate. As discussed above, no new matter is presented by this amendment to the claim, and the resulting method provides important advantages in the fabrication of integrated circuits.

For similar reasons as discussed above relative to amended claims 1 and 7, Applicant respectfully submits that amended claim 13 is patentably distinct over the prior art of record in this case. While the Nozaki et al. reference discloses the formation of a silicon nitride film, the reference also teaches that oxygen in the final structure is to be avoided, and thus fails to disclose (if not actually discourages) the use of a mixture of nitrogen and oxygen in its gas. The applied secondary references fail to suggest modifying the Nozaki et al. teachings in such a manner as to reach amended claim 13, because none of these references disclose the plasma formation of a film from a gas containing both nitrogen and oxygen. Rather, the Tseng reference teaches the formation of its film by deposition of nitride and its subsequent oxidation,



and the Iyer reference teaches chemical vapor deposition of its silicon oxinitride. The Taft et al. reference also provides no teachings or suggestion in this regard. Applicant therefore respectfully submits that the secondary references provide no suggestion to modify the teachings of the Nozaki et al. reference in such a manner as to reach amended claim 13. Applicant therefore respectfully submits that amended claim 13 are patentably distinct over the prior art of record in this case.

The other references cited by the Examiner have been considered, but are not felt to come within the scope of the claims in this case.

For all of the above reasons, Applicant respectfully submits that all claims now in this case are in condition for allowance. Reconsideration of the above-referenced application is therefore respectfully requested.

Respectfully submitted,

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